at $83\frac{1}{2}^{\circ}$, he concludes that the compensation which takes place is produced neither by an equality of oppositely polarized rays, nor by a proportional admixture of common light, but by equal and opposite physical states of the whole pencil, whether reflected or refracted.

The remarkable phenomena produced at an angle of incidence on glass of 82° 44′ (at which angle $\cos(i + i') = \cos^2(i + i')$), led the author to the construction of what he terms *the compensating rhomb*, consisting of a well annealed rhomb of glass, or any other uncrystallized substance, having the angles of its base 130° 25′ and 46° 35′ respectively, when the index of refraction is 1·525. When a ray of light is incident upon the first surface at an angle of 82° 44′, exactly one-half of it is reflected; and the other half, after refraction, is reflected at the second surface, and emerges perpendicularly to the adjacent surface, without suffering refraction; each portion having, in the first instance, the same quantity of polarized light. The second portion is found, on examination, to be in the state of common light, although the ray at the second incidence consisted of more than one-half of polarized light. Hence if the pencil, previously to reflexion at the second surface, consist of 145 rays of polarized light, and 188 of common light, the effect of a single reflexion must be to depolarize polarized light, and to produce no change whatever upon common light, a property of a reflecting surface never yet recognized, and incompatible with all our present knowledge on the subject of the polarization of light.

The author then describes an instrument which he has invented for the purpose of accurately measuring the degrees of polarization, and which he therefore terms a *Polarimeter*. It consists of two parts; one of which is intended to produce a ray of compensation having a physical character susceptible of numerical expression, and the other to produce polarized bands, or rectilineal isochromatic lines, the extinction of which indicates that the compensation is effected. The construction and mode of operation of this instrument are, by the aid of figures, described and explained.

The following is the general law established by these researches; namely, that the compensations of polarized light are produced by equal and opposite rotations of the planes of polarization. Thus, when a ray of common light is incident, at any angle, upon the polished surface of a transparent body, the whole of the reflected pencil suffers a physical change, bringing it more or less into a state of complete polarization, in virtue of which change its planes of polarization are more or less turned into the plane of reflexion; while the whole of the refracted pencil has suffered a similar, but opposite change, in virtue of which its planes of polarization are turned more or less into a plane perpendicular to the plane of reflexion.

The author then enters into a theoretical investigation of the subject, and concludes by pointing out a few of the numerous applications of his theory.

2. Continuation of the paper of which the reading commenced

at the last Meeting, and entitled, "Researches tending to prove the Non-vascularity of certain Animal Tissues, and to demonstrate the peculiar uniform mode of their Organization and Nutrition." By Joseph Toynbee, Esq. Communicated by Sir Benjamin C. Brodie, Bart., F.R.S.

In the introduction to this paper, the author first speaks of the process of nutrition in the animal tissues which are pervaded by ramifications of blood-vessels; pointing out the circumstance, that even in them there is a considerable extent of tissue which is nourished without being in contact with blood-vessels. The knowledge of this fact leads us to the study of the process of nutrition in the non-vascular tissues; which tissues he divides into the three following classes; namely, first, those comprehending articular cartilage, and the cartilage of the different classes of fibro-cartilage. Under the second head he comprises the cornea, the crystalline lens, and the vitreous humour; and, under the third, he arranges the epidermoid appendages; viz. the epithelium, the epidermis, nails and claws, hoofs, hair and bristles, feathers, horn and teeth.

The author then proceeds to show that the due action of the organs, into the composition of which these tissues enter, is incompatible with their vascularity. In proof of the non-existence of blood-vessels in these tissues, he states that he has demonstrated, by means of injections, that the arteries, which previous anatomists had supposed to penetrate into their substance, either as serous vessels, or as red-blood vessels too minute for injection, actually terminate in veins before reaching them; he also shows that around these non-vascular tissues there are numerous vascular convolutions, large dilatations and intricate plexuses of blood-vessels, the object of which he believes to be to arrest the progress of the blood, and to allow a large quantity of it to circulate slowly around these tissues, so that its nutrient liquor may penetrate into and be diffused through them. The author states that all the non-vascular tissues have an analogous structure, and that they are composed of corpuscles, to which he is induced to ascribe the performance of the very important functions in the process of their nutrition, of circulating throughout, and perhaps of changing the nature of the nutrient fluid which is brought by blood-vessels to their circumference. The author then brings forward facts in proof of the active and vital properties of these corpuscles, and concludes his Introduction by stating, that it appears to him, that the only difference in the mode of nutrition between the vascular and the non-vascular tissues is, that in the former, the fluid which nourishes them is derived from the blood that circulates throughout the capillaries contained in their substance; whilst, in the latter, the nutrient fluid exudes into them from the large and dilated vessels that are distributed around them: and that in both classes, the particles of which the tissues are composed derive from this fluid the elements which nourish them.

The author then enters on an examination of the structure and mode of nutrition of the several tissues of each of these three classes.

In considering the first class, he commences with articular cartilage, which he describes at great length in the various stages of its developement, and at the different periods of life. He gives in detail the account of numerous dissections of the ovum and fœtus illustrating the first stage, during which he shows that no blood-vessels enter into the substance of any of the textures composing a joint; but that the changes its component parts undergo, are effected by the nutrient fluid from the large blood-vessels, by which, at this stage, each articulation is surrounded. In the second stage of the developement of articular cartilage, the author shows, by numerous dissections, the process by which the blood-vessels are extended into the substance of the epiphysal cartilage, and converge towards the attached surface of articular cartilage, and how, at the same time, blood-vessels are equally prolonged over a certain portion of its free surface. He shows that none of these blood-vessels enter the substance of the articular cartilage, and he points out that in them the arteries become continuous with the veins; first, by their terminating in a single vessel, from which the veins arise; secondly, by their forming large dilatations from which the veins originate; and, lastly, they become directly continuous with the veins in the formation of loops of various characters. In the third stage, that which is exhibited in adult life, the epiphysal cartilage is converted into osseous cancelli. These contain large blood-vessels, which are separated from the articular cartilage by a layer of bone composed of corpuscles, and the author believes that the principal source of nutrition to this tissue is the nutrient fluid which exudes into it from these vessels, by passing through the articular lamella just noticed. The free surface of adult articular cartilage is nourished by vessels which pass to a slight extent over it. The author points out the presence of fine tubes which pervade the attached portion of adult articular cartilage, to which he ascribes the function of transmitting through its substance the nutritive fluid derived from the vessels of the cancelli. He also advances the opinion that the articular cartilage becomes thinner during the whole of life, by being gradually converted into bone.

Fibro-cartilage constitutes the second tissue of the first class. The author first enters upon an examination of its structure; and in order to arrive at some definite conclusions on this subject, whereon anatomists of all ages have so much differed, he made numerous dissections of fibro-cartilages in the different classes of animals at various periods of their developement, the results of which he details. He arrives at the conclusion that this tissue is composed of cartilaginous corpuscles and of fibres; the latter preponderating in adult life, the former in infancy; and that during life the corpuscles are gradually converted into fibres. He enters at length into the question of the vascularity of these cartilages; and from a careful study of many injected specimens of man and animals at various periods of their developement, the particular results of which he relates, he believes that blood-vessels are contained only in their fibrous portion, and have the function of nourishing that which is cartila-

ginous, and which, on account of its being subject to compression and concussion, does not contain any.

Among the second class of extra-vascular tissues, the cornea is first treated of; and its structure is described as being very lax, and as containing corpuscles only in a small quantity. The opinions in favour of its vascularity are combated; and it is shown that the blood-vessels which converge to its attached margin, and which are the principal source of the fluid that nourishes it, are large and numerous, and that at the circumference of this tissue the arteries, without any diminution of their calibre, return in their course, and become continuous with the veins. A second set of vessels, devoted to the nutrition of the cornea, is also described; they extend to a short distance over the surface of the tissue, but do not penetrate into its substance.

The crystalline lens is described as being composed of corpuscles, of which the radiating fibres are constituted. The arteria centralis retinæ is described as ramifying over the posterior surface of the capsule, where it forms large branches; these pass round the circumference of the lens, and reach its anterior surface, at the periphery of which they become straight: the arteries terminate in loops frequently dilated, and become continuous with the veins. With respect to the vascularity of the vitreous humour, the author states that although many anatomists have, in general terms, represented the arteria centralis retinæ as giving off, in its course through this organ, minute branches into its substance, still those who have paid especial attention to the subject, have not been able to find such vessels. He believes that the nutrition of this structure is accomplished by the fluid brought to its surface by the ciliary processes of the choroid, which fluid is diffused with facility through its entire substance by means of the corpuscles of which its membrane is composed, assisted by the semifluid character of the humour.

The third class of extra-vascular tissues comprehends the epidermoid appendages. The author describes them all as composed of corpuscles, which are round and soft where they are in contact with the vascular chorion, compressed and flattened where they are farther removed from it. He points out, in the substance of the hoof of the Horse, the existence of fine canals, which he supposes to conduct fluid through its mass; and he states that the perspiratory ducts of the human subject possess a structure analogous to the spiral vessels of plants. The author describes each of the tissues of this class at length, and shows that the various modifications presented by the vascular system with which each is in contact, have the sole object of enabling a large quantity of blood to approach and circulate slowly around them. He also points out, in connexion with this subject, the remarkable vital properties which are possessed by these non-vascular tissues.

In concluding this paper, the author states that his object has been to establish as a law in animal physiology, that tissues are capable of being nourished, and of increasing in size, without the presence of blood-vessels within their substance. He shows the analogy

which is presented between the extra-vascular animal and the extra-vascular vegetable tissues. He expresses a hope that the application to surgery of the above law, with reference to the prolongation of blood-vessels into the extra-vascular tissues during disease, and to pathology in the investigation of the nature of morbid structures, particularly of those classes which contain no blood-vessels, will be not devoid of interest, and will be productive of some advantage.

The Society then adjourned over the Whitsun recess, to meet again on the 10th of June next.

June 10, 1841.

The MARQUIS OF NORTHAMPTON, President, in the Chair.

The Most Noble the Marquis of Westminster, Sir Thomas Baring, Bart., Edward Blore, Esq., Samuel Seaward, Esq. and Alfred Smee, Esq., were balloted for, and duly elected into the Society.

The following papers were read, viz.—

1. "Magnetic-term Observations made at Milan, on the 21st and 22nd of April, 1841." Communicated by Professor Carlini, For. Memb. R.S.

2. "Register of Tidal Observations made at Prince of Wales's Island, in July, August and September, 1840."

3. "Register of Tidal Observations made at Singapore in July, August and September, 1840."

These two papers were presented by the Directors of the East India Company, and communicated by P. M. Roget, M.D., Sec. R.S.

4. "On the Anatomy and Physiology of certain structures in the Orbit, not previously described." By J. M. Ferrall, Esq., M.R.I.A. Communicated by Sir Benjamin C. Brodie, Bart., F.R.S.

The author describes a distinct fibrous tunic, which he terms the *tunica vaginalis oculi*, continuous with the tarsal cartilages and ligaments in front, and extending backwards to the bottom, or apex of the orbit; thus completely insulating the globe of the eye, and keeping it apart from the muscles which move it. The eye-ball is connected with this fibrous investment by a cellular tissue, so lax and delicate as to permit an easy and gliding motion between them. The use which the author assigns to this tunic is that of protecting the eye-ball from the pressure of its muscles while they are in action. This tunic is perforated at its circumference, and a few lines posterior to its anterior margin, by six openings, through which the tendons of the muscles emerge in passing to their insertions, and over which, as over pullies, they play in their course. A consequence of this structure is that the recti muscles become capable of giving rotatory motions to the eye without occasioning its retraction within the orbit, and without exerting injurious pressure on that organ. In those animals which are provided with a proper retractor muscle,